

of this is that when applied with a spray, the broad pulpy leaves of the chickweed absorb a large quantity of the solution, while the narrow, hard leaves of the grass absorb very little; when applied with a watering pot the solution goes to the roots and kills the grass.

The Use of Chemical Weed Killers on Golf Courses

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The use of chemical plant poisons as a means of eradicating and controlling weeds originated about 1895; hence the method is comparatively new. Although the use of chemicals offered great promise, further experimentation has demonstrated that the method has but limited practical use. There are situations, however, in which chemicals are helpful. There is a great deal of popular interest in the subject; but public knowledge concerning chemical weed killers is very scant. It is the purpose of this article to show where chemicals are useful in dealing with weeds on golf courses and to point out the limitations of the method.

In general, weeds on golf courses are troublesome mainly on putting greens, except in the cases of perennials, especially those possessing wind-distributed seeds, as the dandelion, growing in the rough and on the fairway. Weeds of this type should be eliminated whenever practicable in order to prevent the possibility of infesting nearby greens.

Chemical Control of Annual Weeds

In general, such annual weeds as crab-grass, shepherd's purse, and pigeon-grass can not be controlled economically on golf courses by chemical means. These plants must be controlled by (1) improving the turf so the grass will be vigorous, thus tending to crowd the weeds out, or (2) by hand weeding.

With one species, common chickweed, successful results have been obtained by spraying with a solution of sodium arsenite prepared at the rate of 6 pounds of the chemical in 50 gallons of water. To be successful, the work must be commenced early in April, before the chickweed has made a heavy growth. Iron sulphate* has also been quite effective against chickweed. For this purpose the solution should be prepared at the rate of 100 pounds of the sugar form of iron sulphate dissolved in 50 gallons of water and applied as a fine, driving mist. Compressed-air hand-sprayers suitable for this work can be purchased for about \$8. Neither the arsenite nor the iron sulphate spray will cause permanent injury to the turf, but the arsenite is a potent internal poison and grazing animals should not have access to the sprayed vegetation.

Chemical Control of Perennial Weeds

Perennial weeds as they occur on golf courses are of two general types, those that reproduce from running underground parts, such as

*The names of dealers in iron sulphate and other chemical weed killers and of distributing agents for weed-killing devices can be obtained on application to the secretary.



Applying chemical weed killer by means of a bucket pump, a method adapted to small areas.

speedwell, creeping thyme, and ground ivy, and those that reproduce by means of heavy crowns, the most conspicuous examples of which are the dandelion and plantain (rib-grass).

Chemical plant poisons have little use where it is desired to kill the creeping type of perennials, since if the above ground growth is killed by this means new shoots will soon arise from the underground structures. If the soil is sufficiently saturated to kill the underground parts, it will at the same time be sterilized against the growth of good turf plants. The only practical means of dealing with this class of weeds is to cut out the patches of weedy turf and resod.

Chemicals are useful, however, in eradicating weeds of the dandelion type. Where they do not occur in great abundance, dandelions may be killed by the application of gasoline, kerosene or carbon bisulphide to the individual plants. A very useful and inexpensive device for this purpose is now on the market. It consists of a tube with a valve on one end and a handle on the other. The tube is filled with gasoline and as each plant is stabbed with the valve end, a small amount of gasoline is deposited. The method is too laborious to advocate except where the weeds are few in number and scattered over the turf. Plantains have also been successfully controlled with crude carbolic acid used full strength and applied to the individual plants by means of a spring-bottom oil can or with the device above mentioned. The method is useful only when the plantains do not occur in large numbers.

A method of controlling dandelions by spraying with iron sulphate

has recently been developed. The spray solution is prepared by dissolving iron sulphate at the rate of 1 to 1½ pounds per gallon of water and spraying five times during the season, the first time just as the blossoms unfold during the early spring, and at intervals of a month thereafter. The method is useful on large, heavily infested areas where the grass is vigorous, particularly on bluegrass turf. On Bermuda grass, redtop, and bent grass turf the method is not to be recommended. Spraying will not eradicate the dandelions entirely, but will so diminish the number that the turf can be kept practically free of the weed for several years afterward with comparatively little effort. The spray kills the white clover and gives the grass a darkened appearance for a few days. Before investing in expensive spraying machinery, the method should first be tried out on a small scale with a hand-spraying outfit to determine its practicability under the conditions presented.

The results of European experiments indicate that weedy mosses growing on the turf can be controlled by spraying with a 5 per cent solution of iron sulphate followed by sprinkling several times with a 3 per cent solution of nitrate of soda. The method has not been tried extensively in America. The little experimental work that has been done along this line indicates that iron sulphate will kill the weak annual mosses, but when used against the more vigorous perennial mosses, defoliation results, followed by renewed growth of the treated plants. The moss problem is usually dealt with by drainage or by the application of lime.

Chemical Methods for Destroying All Vegetation

For situations where the permanent destruction of all vegetation is desired, as on sand greens, edges of clay tees, and in bunkers, chemical weed killers will probably find their greatest usefulness. In addition, they can be used to advantage on gravel walks and driveways, in gutters around the clubhouse and on tennis courts.

The most effective and economical chemical for destroying all vegetation is sodium arsenite in solution. It is the basis of practically all commercial weed killers. On small areas, or for test purposes, it is most economical to purchase such solutions already prepared. Most large dealers in garden supplies sell commercial chemical "weed killers."

Where the area to be treated is large, as on sand greens, home-made solutions are most economical. The following formula has the advantages of generating its own heat and yielding a high-grade product, but has the disadvantage of needing extremely exact procedure in order to obtain good results, and in addition the sodium hydroxide or the high-grade lye necessary are not always readily obtainable.

Granulated caustic soda (sodium hydroxide)	2 pounds
or	
High grade concentrated lye	3 pounds
White arsenic (arsenic trioxide)	4 pounds
Water, to make	1 gallon

The solid ingredients should be mixed in a wooden, granite, or earthen vessel, and the water added slowly, stirring vigorously in the meantime. The chemical action develops much heat so that the preparation is self-boiled, but if some of the arsenic is undissolved, the mixture must be re-boiled until all of it enters in solution. After cooling (never before cooling), sufficient water should be added to replace the amount lost in

boiling. The solution should be used within a week after preparing, or else stored in air-tight receptacles. Apply in diluted form, using 1 gallon to 50 gallons of water.

Where the preceding formula is inconvenient, another may be used which has the advantage that the ingredients are more readily obtainable. Its principal disadvantage is the necessity of boiling by means of fire. Furthermore, the product is not quite as effective as the product of the preceding formula.

Washing soda (sal-soda, sodium carbonate) ..	8 pounds
or	
Soda-ash (anhydrous sodium carbonate)	4 pounds
White arsenic	4 pounds
Water, to make	1 gallon

Boil the mixture until a complete solution is obtained. The result is a stock solution, a gallon of which should be added to 50 gallons of water when ready to use.

In addition to the home-made products another choice is offered. Arsenite of soda may sometimes be obtained already prepared, ready to dissolve in water. The formula in this case is 1 pound of sodium arsenite (arsenite of soda) dissolved in 10 gallons of water and used direct.

The solutions should be applied at the rate of approximately 600 gallons per acre by means of a sprinkling can, watering cart, or hose equipped with a nozzle. The best time to apply the poisons is on cloudy days, since they evaporate too rapidly during dry, hot weather. In case a dense growth of vegetation exists, it is best to mow before spraying. Several sprayings may be necessary in order entirely to kill the perennial weeds.

A word of caution is necessary in handling arsenical compounds. Arsenic is a dangerous internal poison, and grazing animals should be kept away from the sprayed areas. Furthermore, arsenical dust should not be inhaled while preparing the weed-killing solutions. Caustic soda is also dangerous to handle, since it burns the skin readily; hence bare hands should never be allowed to touch it.

Another chemical that may find use where the complete destruction of vegetation is desired, is common salt applied dry every three or four years at the rate of 1 to 2 pounds per square foot of area treated. Most vegetation succumbs to the effects of salt, but several grasses are immune, particularly Johnson grass and Bermuda grass. For weed-killing purposes, the cheapest grade of salt obtainable is most economical. The grade called agricultural salt, consisting of dirty and off-color salt, is usually cheapest. Ice cream factories use a cheap grade of salt useful for killing weeds. Salt may also be sprayed in saturated solution (about 3 pounds for each gallon of water) at the rate of 400 gallons per acre.

Fertilizer

Modern commercial fertilizers are called "complete" when they contain nitrogen, potash and phosphorus. These three elements have been found to be the most generally useful to stimulate the growth of plants. For grasses, at least, nitrogen is as a rule far more effective than are potash or phosphorus or both. Nitrogenous fertilizers may be *inorganic* or *chemical*, as for example nitrate of soda and sulphate of ammonia; or *organic*, as bone meal, cottonseed meal, tankage, fish scrap, etc. Barnyard manure is a complete fertilizer but rich in nitrogen.